BELLCOMM, INC.
955 L'ENFANT PLAZA NORTH, S.W. WASHINGTON, D. C. 20024

B69 03101

SUBJECT: Trip Report: Twenty-third AAP Flight Operations Plan (FOP) Meeting, MSC, March 21, 1969 - Case 610

DATE: March 28, 1969

FROM: D. J. Belz

MEMORANDUM FOR FILE

The Twenty-third AAP Flight Operations Plan (FOP) Meeting was held at MSC on March 21, 1969. This memorandum summarizes several items of interest reported at that meeting.

I. Service Module Battery Pack

The addition of battery packs to AAP Service Modules has been under consideration for some time as a means of increasing the electrical power available from separation of the CSM/Workshop through recovery. Mr. W. E. Koons - MSC/FA reported that the MSC Apollo Applications Program Office (AAPO) has decided not to include the battery pack. This decision was reportedly based on a study which showed that the basic Apollo battery capability would provide adequate power for a separation, entry, and post-landing sequence even if the Service Propulsion System, Primary Guidance and Navigation System and all fuel cell modules failed prior to CSM/Workshop separation.

II. Thermal Constraint on Open LM-A EVA Hatch

Grumman Aircraft Engineering Corporation (GAEC) has been analyzing the LM-A design to determine whether a thermal constraint exists on the amount of time the LM-A EVA hatch can be permitted to remain open in orbit. Provided an ATM sun-oriented attitude is maintained, maximum design temperatures in the LM-A interior will not be exceeded with the EVA hatch open. The question of whether LM-A interior temperatures may fall below minimum design limits within the duration of an EVA is still under study.

III. Night Launch and Night Landing Study

MSC's Landing and Recovery Division (LRD) reported the results of a study on the acceptability of night launches and night landings. KSC's position is that it can support night launches at no additional cost to that of day launches. MSC's Flight Crew Operations Directorate has taken the position that night launches are "acceptable but undesirable" with AAP launch and recovery systems. Although LRD prefers daylight recovery, it reportedly can support night recovery operations

(NASA-CR-104034) TRIP REPORT - TWENTY-THIRD AAP FLIGHT OPERATIONS PLAN /FOP/ MEETING, MSC, 21 MARCH 1969 (Bellcomm, Inc.) 31 p

N79-71609

Unclas
00/12 11506

FF No. 6
CR-104034
(NASA CR OR TMX OR AD NUMBER) (CATEGORY)
[redacted]

without added costs. (Disadvantages of night recovery include loss of TV coverage and the possibility that lights in the recovery area might attract sharks.) LRD further recommended that recovery zones be restricted to the northern hemisphere to avoid additional cost for logistics.

IV. Concurrent Lunar and AAP Missions

MSC's Flight Support Division (FSD) presented the results of a study on concurrent lunar and AAP missions: no restrictions were identified provided a lunar launch and any AAP launch occurred more than a day apart. During discussion it was pointed out that distinct S-Band frequencies would be required for a lunar CSM and an AAP CSM if both were flying concurrently.

V. Duration Between AAP-3 and AAP-4 Launches

Mr. B. Ferguson - MSC/CF34 presented the results of a study to determine the time required between the AAP-3 and AAP-4 launches. If MDA and OWS pressurization and activation are to be completed prior to LM-A/ATM docking, the estimated minimum time from CSM docking to AAP-4 launch is 62.0 hours. If the OWS is not to be pressurized prior to LM-A/ATM docking, the estimated minimum time from CSM docking to the AAP-4 launch is 37.0 hours.

VI. Mission Constraints Document

The FOP group is compiling a Mission Constraints Document to identify systems limitations pertinent to individual AAP flights. Early editions, to be published as updates to the Baseline Reference Mission document will provide a guide for mission planners; the final issue will provide a basis for establishing the operational mission rules for each AAP flight. A preliminary draft of the constraints document was issued and discussed at the meeting. A copy of the draft is attached to this memorandum. Comments by MLS staff members on its contents and format will be welcomed. Such comments may be sent to the writer as candidates for submission to the FOP Mission Constraints Working Group.

D. J. Belz

1025-DJB-dcs

Attachment

PRELIMINARY

AAP MISSION CONSTRAINTS

March 21, 1969

Prepared by FCOB, FCD

*

CONTENTS

* AAP MISSION CONSTRAINTS

1.1 GENERAL

1.1.1 Formulation of Mission Constraints

The various systems handbooks and supporting documentation define the limits, guidelines, and procedures that went into the makeup of the basic AAP mission. Some of the limits and guidelines are of such a restrictive nature that they constrain the mission within restrictive boundaries. The purpose of this section is to present in one area those limitations that formulate the AAP mission constraints.

This section contains only mission constraints. Limits, redline values, and guidelines will be presented in the AAP Operations Data Book. The mission rules and procedures will be listed in the Flight Plan and Mission Rules.

1.1.2 Definitions

The following definitions were used in deriving this section:

A. Constraints - Those philosophies (methods, manner, or procedures) and system's limitations which shape or influence the trajectory, crew timeline, or ground system's timeline.

B. Limitations - Those system's limits which, if exceeded and if they are measurable or detectable (during or preflight), could potentially: (1) affect flight operations (trajectory design, crew timeline, or ground system's timeline); (2) cause a degraded mission; and/or (3) cause dangerous performance (unsafe operating condition). Usually these limits would not be normal operating limits nor spec operating limits. However, early in the program these may be the only available limits.

   Most limitations will be quantitative in nature, such as temperature, pressure, volts, current, et cetera. Crew procedures for avoiding the violation of a limit should not be considered as a limitation in general. Normal consumable quantities, engine performance data, and such, should not be considered as limitations.

*

C. Guidelines - Those items which express a preference as to operating conditions. The guidelines may be based on comfort, "nice to have," or some rationale other than system's limitations. As a rule, the mission could be expected to continue if the guideline is violated. It is possible for some guidelines to become constraints as more system's knowledge is gained.

2.1 PROGRAMATIC CONSTRAINTS

The mission will be terminated within a few hours after the loss of deorbit capability in either the SM-RCS or the SPS.

The mission will be terminated within 24 hours after the failure of two fuel cells.

*

3.1 SYSTEMS CONSTRAINTS

3.1.1 Launch Vehicle Constraints

3.1.1.1 AAP-2

A. Continuous communication and tracking coverage is required for all phases of L/V powered flight.

B. Guidance command angle rate shall not exceed one degree per second in pitch and yaw (first stage tilt program and upper stage guidance program).

C. Maximum command attitude in the yaw plane shall not exceed 45°.

D. Also, see Table 1 for L/V network coverage constraints.

3.1.1.2 AAP-1, AAP-3A, and AAP-3

A. Continuous communication and tracking coverage is required for all phases of L/V powered flight.

B. Guidance command angle rate shall not exceed one degree per second in pitch and yaw (first stage tilt program and upper stage guidance program).

C. Maximum command attitude in the yaw plane shall not exceed 45°.

D. Also, see Table 2 for L/V network coverage constraints.

3.1.1.4 AAP-4

A. Continuous communication and tracking coverage is required for all phases of L/V powered flight.

B. Guidance command angle rate shall not exceed one degree per second in pitch and yaw (first stage tilt program and upper stage guidance program).

C. Maximum command attitude in the yaw plane shall not exceed 45°.

D. Also, see Table 3 for L/V network coverage constraints.

*

3.1.2 Command and Service Module (CSM)

3.1.2.1 Electrical Power Subsystem (EPS)

A return battery pack deorbit operation (with three inoperative fuel cells) must not use more than 2300 watts of average power for a maximum time limit of more than 3.6 hours, from CSM-OA separation until CM-SM separation.

3.1.2.2 Environmental Control Subsystem (ECS)

A. A portable soft duct assembly must exchange atmosphere between the MDA/AM and the CM when the MDA/AM is supplying a CO_2 removal and a humidity control capability to the CM.

B. Potable water must not be turned into waste water unless it is unavoidable. When the CM potable tank is about 97% full, the excess potable water would be transferred to (portable) potable water tanks for conservation and use by the OA.

C. Automatic and manual water dumping must be prevented during LM-ATM experiment phases when the venting would interfere with the data gathering phases of the LM-ATM experiments.

D. The waste management subsystem must be prevented from dumping gasses or liquids during LM-ATM experiment phases when the venting would interfere with the data gathering phases of the LM-ATM experiments.

E. A CM cold-soak operation must be performed by the ECS for several hours, prior to the CSM deorbit and the CM-SM separation operation.

F. A CM cold-soak operation and a water/glycol reservoir cold-soak operation must be performed by the ECS for several hours prior to launch vechicle liftoff.

*

3.1.2.3 Guidance and Control Subsystem (G&C)

The following CSM maneuvers must be avoided when the IMU is in operation:

A. Yaw maneuvers greater than $\pm 75^\circ$ when the roll angle is 0 or 180°.

B. Pitch maneuvers greater than $+42^\circ$ or greater than -180° when the roll angle is $\pm 90^\circ$.

3.1.2.4 Service Propulsion Subsystem (SPS)

The SPS thrusting period must be 4 seconds ± 1 second or longer before the SPS propellant quantity gaging system will register.

3.1.2.5 Reaction Control Subsystem (SM-RCS and CM-RCS)

A. SM-RCS engines must not accumulate more than 2500 seconds of engine burning during a single continuous burn.

B. 1200 pounds of SM-RCS propellant must be reserved for an SM-RCS backup deorbit operation.

C. SM-RCS propellant offloading operations must be restricted to 600-pound increments.

D. When the CSM is docked to the LM/ATM on a backup AAP-3/AAP-4 mission, the CSM -X (forward firing engine) RCS jets must not be fired for more than 7 seconds during a single continuous burn.

3.1.2.6 Communication Subsystem

A. The line of sight slant range of a duplex VHF/AM voice communication operation with MSFN must not exceed 1150 n.mi.

B. The line of sight slant range of a telemetry operation between the CSM and the LM/ATM must not exceed 320 n.mi.

3.1.2.7 Cryogenic Storage Subsystem (CSS)

None

*

3.1.2.8 Thermal Control Subsystem (TCS)

A. The SM-RCS exhaust impingement areas that are bombarded by a +X translation (aft firing exhaust plume) must not receive more than 2400 seconds of impingement during a single continuous burn.

B. The SM-RCS exhaust impingement areas that are bombarded by a -X translation (forward firing exhaust plume) must not receive more than 11 seconds of impingement during a single continuous burn.

C. The following groups of thermal control heaters must be manually turned on approximately 3 hours just prior to an EVA operation so they can be manually turned off for approximately 3 hours during the EVA operation.

1. SM-RCS
   a. Shelf Heater, Bay 3
   b. Propellant Storage
   c. Module, Bay 3
   d. Propellant Storage
   e. Module, Bay 6
   f. Shelf Heater, Bay 6
2. SPS
   a. Tank Heaters, Bay 2 (Oxygen)
   b. Tank Heaters, Bay 5 (Fuel)

D. When the CSM is docked to the LM/ATM on a backup AAP-3/AAP-4 mission, the CSM exhaust impingement areas that are bombarded by a LM-X (forward firing engine) RCS jet must not receive more than 6 seconds of impingement during a single continuous burn.

3.1.3 Orbital Workshop (OWS)

3.1.3.1 Electrical Power System (EPS)

None

*

3.1.3.2 Environmental Control System (ECS)

When in X-pop mode, 180° flip is required when negative beta exceeds 10°.

3.1.3.3 Passivation System (PAS)

A. The S-IVB stage must be passivated prior to CSM docking.

B. Pneumatic supply pressure must be retained for 30 to 33 hours after orbital insertion.

C. Meteoroid shield must be deployed before astronaut entry but not prior to passivation completion.

D. S-IVB stage batteries must be passivated prior to astronaut entry.

3.1.3.4 Activation System

The LH_2 tank must be sealed after CSM docking but prior to (TBD) hours after initial pressurization.

3.1.3.5 Workshop Attitude Control System (WACS)

One hundred pounds of ACS propellant must be reserved for AAP-3/4 operations.

3.1.4 Airlock Module (AM)

3.1.4.1 Electrical Power Systems (EPS)

A. Individual AM batteries shall not be discharged below an energy level of :

1. __________amp-hours, during mission AAP-1/AAP-2.

2. __________amp-hours, during orbital storage.

B. Battery discharge of 33 amp-hours to the discharge voltage of 30 volts. Eight batteries available.

3.1.4.2 Environmental Control System (ECS)

A. Contamination of the radiator surface coatings is limited to effective surface emissivity of ≥ 0.85 and absorptivity of ≤ 0.25.

*

B. The average total metabolic heat load must be maintained below 1500 BTU/hr.

C. The two molecular sieve beds in each molecular sieve unit must be "baked out" after the partial pressure of CO_2 reaches a maximum of 15 mm Hg.

D. The total volume of each airlock O_2 accumulator tank (2 tanks) is 2.98 ft^3, limiting the duration capability of high O_2 flow rates.

3.1.4.3 Communications System

A. No more than 4 hours of data can be recorded without tape dump.

B. Digital command repetition rate should not exceed one command every ________ seconds for the 1-amp special real-time commands (SRTC).

3.1.5 MDA

See AM and other modules interfacing with the MDA.

3.1.6 Lunar Module

3.1.6.1 Electrical Power System

A. Total LM-A battery capacity is 30 kWh.

B. Remaining energy in LM-A batteries must be dissipated after docking to OA and CSM.

3.1.6.2 Environmental Control System

A. A radiator network minimum total heat load of TBD BTU/hr must be maintained.

B. Total water usage shall not exceed 160 pounds.

C. Total PCU/LCG support time shall not exceed 8 man-hours of EVA or 32 man-hours total.

*

3.1.6.3 Communications System

A. LM-A communications capability is not available until payload shroud is jettisoned.

B. During URD, the LM-A +X-axis must be pointing to any portion of the CSM with a tolerance of ± 30 degrees.

3.1.6.4 Guidance, Navigation, and Control System

A. IMU middle gimbal angle magnitude should not exceed +70 degrees or -70 degrees.

B. PGNS state vector must be updated prior to initial RR acquisition.

C. During LM-A docking, the OA must be actively attitude stabilized.

D. LM-A tracking light must be visible to crewman in MDA.

3.1.6.5 Reaction Control System (RCS)

A. Maximum allowable continuous firing of LM-A and CSM-RCS jets shall be limited to

   1. LM-A, -X; TBD seconds (thrusters, no. TBD)
   2. LM-A, +X; TBD seconds
   3. CSM, -X; TBD seconds (docked to LM-A)

B. Total LM-A usable RCS propellant capacity is 977 pounds.

3.1.6.6 Structural and Mechanical Systems

A. During docking contact of the LM-A to the MDA or CSM, the following parameters should be within the following values:

   1. fps axial closing velocity
   2. 0.5 fps radial closing velocity
   3. 1°/sec angular velocity
   4. 1 ft radial alignment
   5. 10° angular alignment

B. LM-A must be protected from aerodynamic total pressure ("q") above TBD psi.

*

3.1.7 Apollo Telescope Mount (ATM)

3.1.7.1 Electrical Power System

A. Batteries must not be discharged below 70 percent of their rated capacity in the operational mode.

B. The maximum average power the ATM electrical system can supply is TBD. Determination must be made with regard to solar array capability, including array orientation, and the energy transfer function (on-orbit determination).

C. The ATM solar array must be maintained normal to the sun vector.

3.1.7.2 Communications System

A. A complete dump of tape recorder data requires 5 minutes. The tape moves in the same direction in both record and playback modes. Even when the tape is not full, the most recently recorded data is not played back until the end of the 5 minute playback time.

B. A maximum of 90 minutes of data can be recorded on the onboard tape recorder.

C. Solar array wing deployment is a prerequisite to telemetry and command systems operation. The command antenna and one telemetry antenna are located on the end of Wing 710. The other telemetry antenna is on the end of Wing 713.

3.1.7.3 Pointing Control System

A. Maximum roll rate of the spar is $\pm 7^\circ$/sec.

B. The star tracker becomes generally unreliable when the reference star is:

1. Within 5° of being occulted by the earth's surface,
2. Beyond $\pm 40^\circ$ from the inner gimbal-centered position,
3. Beyond $\pm 87^\circ$ from the outer gimbal-centered position,

*

4. Within 45° of the sun, or

5. Within TBD degrees of the spacecraft structure.

C. Allowance for CMG spinup prior to PCS activation must exceed 8 hours to accomplish nominal wheel speed.

NOTE

System design requirement per CMG specification is to achieve 7850 rpm (100 percent speed) in 9 hours.

D. Spar roll angle is limited with respect to ATM rack orientation to ±120°.

E. Maneuvering rates of the CMG subsystem are limited to ±0.03°/sec (pitch/yaw) and 0.3°/sec (roll).

F. Automatic gravity-gradient momentum-dumping maneuvers, initiated by digital computer (ATMDC), are programed for night (darkside) portions of orbit revs only.

G. Maximum maneuver capability, relative to ATMCC-stored (integrator) null directions, that can be utilized by crew (DAS) interface is:

± TBD degrees (roll)

and/or ± TBD degrees (pitch/yaw)

H. Momentum-exchange (torque-time product) of CMG subsystem is limited. Net momentum-vector biases away from nominal, $H_x = H_y = H_z$ position should not be permitted to cause the following ratios to be exceeded:

$$\frac{H_x}{H_y} - \text{TBD} \; ; \; \frac{H_y}{H_x} - \text{TBD} \; ; \; \frac{H_z}{H_t} - \text{TBD}$$

NOTE

H_t = Total momentum stored;
H_x, H_y, H_z are typified by momentum direction cosines.

I. Maximum momentum dump rate capability is 200 ft-lb/sec.

*

3.1.7.4 Thermal Control System (TCS)

None

3.1.7.5 ATM Experiments

A. S052 White Light Coronagraph

1. Two runs per day are scheduled.
2. Scheduled for 30 consecutive orbits.
3. Scheduled for 20 patrol orbits.
4. Scheduled for runs during the limb flare activity.
5. Must orient to the center of the solar disc within 20 arc seconds in pitch and yaw with a pointing stability of ± 5 arc seconds.
6. Environment shall be limited to $70^\circ \pm 6^\circ$F.
7. There must be no RCS firing or waste dump in sunlight or when the ATM aperture cover is open.
8. All experiment power must be off during EVA.

B. S054 X-Ray Spectrographic Telescope

1. This experiment cannot operate in the South Atlantic anomaly.
2. The ATM must be pointed toward the sun.
3. No RCS firing, venting, or dumping with the aperture open.

C. S055A UV Scanning Telescope

1. ATM pointing stability of ± 2.5 arc seconds in pitch and yaw and ± 7.5 arc minutes in roll for periods of 100-second duration.
2. The controlled surfaces must have an average temperature between 67° and 69°F $\pm 1^\circ$.
3. Liquid is required for cooling.
4. Differential pressure between ambient and inside of canister shall not exceed 0.1 psi.

5. Pointing of the instrument is accomplished by co-alignment with Hα telescope or S082A.

6. The ATM must be pointed toward the sun.

D. S056 Dual X-Ray Telescope

1. ATM pointing stability of ± 2.5 arc seconds in pitch and yaw and ± 7.5 arc minutes in roll for periods of 100-second duration.

2. Film storage environment limited to $40° \pm 5°F$ and a relative humidity of 40 to 60 percent.

3. Film temperature must not exceed 80°F.

4. Liquid required for cooling.

5. The ATM Hα telescope and TV displays will be used to find targets of interest.

6. The external cover and heat shield must be closed whenever the RCS is operated.

7. The ATM must be pointed toward the sun.

E. S082 UV Spectrograph/Heliograph

1. ATM pointing stability of ± 2.5 arc seconds in pitch and yaw, and ± 7.5 arc minutes in roll.

2. The ATM must be pointed toward the sun.

TABLE-1.--AAP-2 LAUNCH VEHICLE NETWORK COVERAGE CONSTRAINTS

*

	LAUNCH PHASE	ORBITAL PHASE	QUIESCENT PHASE
TRACKING	Continuous tracking from liftoff to 1.5 minutes after S-IVB cutoff.	Two tracking contacts for at least 3 min each revolution.	One series of tracking passes from one site once per week.
TELEMETRY	Continous real-time FCD* from liftoff to S-IVB cutoff plus 1.5 min. Continuous record from liftoff to 1.5 min after S-IVB cutoff.	Real-time FCD and record for at least 6 min by one station each revolution. Continuous real-time FCD during LOX dump.	One series of telemetry passes from one site once per week.
UPDATA	Updata capability from S-IVB cutoff to 1.5 min after S-IVB cutoff.	Updata capability for at least 3 min from one station each rev. Updata capability during LOX dump phase.	Same as telemetry requirements.

*Flight Controller Data

TABLE-2.--AAP-1, 3A, and 3 LAUNCH VEHICLE NETWORK COVERAGE CONSTRAINTS

	LAUNCH PHASE	PRE-SEPARATION PHASE	SEPARATION PHASE	ACTIVE POST-SEPARATION PHASE	DEBRIS PHASE *
TRACKING	Continuous tracking from liftoff to 1.5 minutes after S-IVB cutoff.	Two tracking contacts (180° apart) for at least 3 min each revolution.	Continuous tracking from at least 1 min before separation until 2 min after separation.	One tracking contact for at least 3 min each revolution until the end of L/V. systems life.	One contact each revolution from end of L/V systems life to T+24 hours. Two contacts each revolution from T+24 hours to T+31 hours.
TELEMETRY	Continuous real-time FCD* from liftoff to S-IVB cutoff plus 1.5 min. Continuous record from liftoff to 1.5 min after S-IVB cutoff.	Real-time FCD and record for at least 3 min by two stations (180° apart) each revolution. Continuous real-time FCD during LOX dump.	Continuous real-time FCD and record from at least 1 min before separation until 2 min after separation.	Real-time FCD and record for at least 3 min by one station each revolution until T+5 hours. One record contact is required once each revolution, T+5 hours until the end of L/V systems.	None
UPDATA	Updata capability from S-IVB cutoff to 1.5 min after S-IVB cutoff.	Updata capability for at least 3 min from two stations (180° apart) each rev. Updata capability during LOX dump phase.	Continuous updata capability from at least 1 min before separation until 2 min after separation.	Updata capability for at least 3 minutes from one station each revolution until T+5 hours.	None

*Flight Controller Data

TABLE-3.--AAP-4 LAUNCH VEHICLE NETWORK COVERAGE CONSTRAINTS

	LAUNCH PHASE	PRE-SEPARATION PHASE	SEPARATION PHASE	ACTIVE POST-SEPARATION PHASE	DEBRIS PHASE *
TRACKING	Continuous tracking from liftoff to 1.5 minutes after S-IVB cutoff.	Two tracking contacts (180° apart) for at least 3 min each revolution.	Continuous tracking from at least 1 min before separation until 2 min after separation.	One tracking contact for at least 3 min each revolution until the end of systems life.	One contact each **revolution from** end of L/V systems life to T+24 hours. Two contacts each revolution from T+24 hours to T+31 hours.
TELEMETRY	Continuous real-time FCD* from liftoff to S-IVB cutoff plus 1.5 min. Continuous record from liftoff to 1.5 min after S-IVB cutoff.	Real-time FCD and record for at least 3 min by two stations (180° apart) each revolution. Continuous real-time FCD during LOX dump.	Continuous real-time FCD and record from at least 1 min before separation until 2 min after separation.	Real-time FCD and record for at least 3 min by one station each revolution until T+5 hours. One record contact is required once each revolution, T+5 hours until the end of L/V systems life.	None
UPDATA	Updata capability from S-IVB cutoff to 1.5 min after S-IVB cutoff.	Updata capability for at least 3 min from two stations (180° apart) each rev. Updata capability during LOX dump phase.	Continuous updata capability from at least 1 min before separation until 2 min after separation.	Updata capability for at least 3 minutes from one station each revolution until T+5 hours.	None

*Flight Controller Data

*

4.1 FLIGHT OPERATIONS CONSTRAINTS

4.1.1 Launch Constraints

4.1.1.1 AAP-2 Launch

A. AAP-2 will be launched only on the northerly azimuth.

B. Continuous launch vehicle tracking, telemetry, and command support are mandatory from liftoff through insertion plus 90 seconds.

C. The requirements of the KSC Safety Program (KMI-1710-1A) and AFETR Range Safety Manual (AFETRM 127-1) will apply to NASA operations and missions flown from the AFETR.

4.1.1.2 AAP-1, AAP-3A, and AAP-3 Launch

A. Continuous voice, high-speed tracking, telemetry, and command coverage with the CSM are mandatory from liftoff through insertion plus 90 seconds.

B. Continuous launch vehicle tracking, telemetry, and command support are mandatory from liftoff through insertion plus 90 seconds.

C. The nominal ascent trajectory shall be shaped so that aerodynamic loads during a full-lift, free-fall abort from any point along the trajectory shall not exceed 16 g.

D. For mode II and mode III aborts (Section 9.1), the duration of free fall above the entry interface at an altitude of 300,000 feet shall be at least 100 seconds.

E. The requirements of the KSC Safety Program (KMI-1710-1A) and AFETR Range Safety Manual (AFETRM 127-1) (References 8 and 9) will apply to NASA operations and missions flown from the AFETR.

F. Launch abort, reentry, and recovery in daylight are desirable, but not mandatory.

*

G. The CM couch stroke volume must be adequate for land impact until orbital insertion; subsequently, this volume may be used for storage.

4.1.1.3 AAP-4 Launch

A. AAP-4 will be launched only during northerly opportunities.

~~B. Continuous voice, high-speed tracking, telemetry, and command coverage with the LM/ATM are mandatory from liftoff through insertion plus 90 seconds.~~

C. Continuous launch vehicle tracking, telemetry, and command support are mandatory from liftoff through insertion plus 90 seconds.

D. The requirements of the KSC Safety Program (KMI-1710-1A) and AFETR Range Safety Manual (AFETRM 127-1) will apply to NASA operations and missions flown from the AFETR.

4.1.2 Prerendezvous Operational Constraints

4.1.2.1 AAP-2

A. S-IVB command and telemetry are mandatory for all liquid oxygen (LOX) and liquid hydrogen (LH_2) vent valve openings and LOX closings.

B. S-IVB attitude shall not preclude S-IVB telemetry and command when the vehicle is in line of sight of the MSFN during the passivation phase.

4.1.2.2 AAP-1, 3A, and 3

A. S-IVB command, telemetry, and CSM voice are mandatory for all liquid oxygen (LOX) and liquid hydrogen (LH_2) vent valve openings and LOX closings.

B. S-IVB attitude shall not preclude S-IVB telemetry and command and CSM voice when the vehicles are in line of sight of the MSFN during all of the transposition, docking, and ejection portions of the mission.

*

C. CSM voice and telemetry and S-IVB telemetry and command are mandatory for a GO/NO-GO decision for spacecraft separation within 30 minutes prior to CSM/SLA separation.

4.1.2.3 AAP-4

S-IVB command and telemetry are mandatory for all liquid oxygen (LOX) and liquid hydrogen (LH_2) vent valve openings and LOX closings.

4.1.3 Orbital Operations Constraints - All Missions

4.1.3.1 General

A. There will be at least one man in the CSM at all times. However, he may be asleep. Systems shall be designed so that they do not require the continuous support of a crewman.

B. It is mandatory that emergency abort operations can be initiated at any time during the combined missions. All systems required to support such action shall be maintained in a suitable ready state. Abort shall be implied to mean both separation and reentry operations.

C. The flight crew will be constrained to their assigned command module couches during all major flight maneuvers. Major flight maneuvers are defined as launch, all SPS burns, deorbit, and reentry.

D. The option will be for the crew to be in pressure suits during events such as launch, rendezvous, docking, all SPS burns, initial entry into each module of the orbital assembly, deorbit, and reentry.

E. Each period of EVA will be limited to 3 hours actual EVA time. This is from egress initiate to ingress completion. During these periods, all crewmen will be in pressure suits,

*

two of them being capable of EVA (suits pressurized). Pre- and post-EVA times of about 1 hour each must be added to this EVA planning.

F. Experimental operations requiring significant crew participation shall not be scheduled on the calendar days of launch and recovery.

G. For crew handling purposes within the orbital assembly, all transportable packages must be limited to size and weight values consistent with safe operation and free movement. For planning purposes, these values are those developed by zero g and neutral buoyancy tests as listed below:

1. A maximum size of 20 by 25 by 40 inches with a mass of 75 pounds
2. A maximum size of 18 by 18 by 18 inches with a mass of 150 pounds

In addition, all corners and edges must have a minimum radius of 1 inch.

H. For missions AAP-1/AAP-2 and AAP-3A, the OA will be stabilized by the Saturn I workshop attitude control system (WACS) with the X-axis perpendicular to the orbit plane (X-POP mode). For mission AAP-3/AAP-4, the OA will be stabilized in a sun-oriented mode by ATM mounted control moment gyros (CMG's). The OA longitudinal axis shall lie in the orbit plane. CMG momentum storage dumping is planned to be accomplished by gravity gradient techniques. Should the need arise, it may be done by any vehicle having adequate control capability and supplies at that time. The CSM shall have adequate propellants to perform at least 50 percent of the expected CMG dump requirements. (This ground rule does not impose an operational requirement on SIWS or

*

LM systems. In fact, the open ATM solar arrays may preclude such LM usage except for contingency reasons.)

I. The criticality of the ATM optical surfaces, when exposed, shall be observed. Fuel cell water dumps, waste dumps, RCS firings, or any other identifiable release of liquids or gases shall be planned to occur at times such as to minimize interference with the operation of the ATM experiments. Also, outgassing from materials, leaks from active coolant systems, and leaks from pressurized spacecraft shall be taken into consideration.

J. The SM RCS shall provide backup deorbit capability from any orbital position during the mission.

K. The LM/ATM will dock to the MDA radial port 1. All CSM's will dock to the MDA axial port 5. CSM docking will be the same for all three missions, with the CSM +Z-axis midway (45 degrees) between MDA ports 1 and 4 centerlines.

L. All critical items (to be identified in the design reviews) shall be operable by the crew in a hardsuited condition.

M. The CSM service propulsion system will not be used to maneuver the OA or LM-A/ATM.

N. The mission will be designed so as not to exceed a total radiation dose to the crew of 250 RAD SKIN and/or 25 RAD DEPTH prior to mission completion.

4.1.3.2 MSFN

A. Contact with a ground station having CSM, LM, and AM telemetry; CSM, LM, and AM command; and CSM and AM A/G voice capability for at least 6 minutes during each revolution of coasting flight is highly desirable for active vehicles.

B. CSM, AM, and PLSS telemetry and voice coverage are mandatory during the preparation and GO/NO-GO decision for any extravehicular activity (EVA). Voice and telemetry are

*

highly desirable during the preparation and GO/NO-GO for any intravehicular transfer (IVT). It is highly desirable that the EVA and IVT should be planned such that maximum coverage is provided during the critical sequences.

C. High-speed tracking is mandatory for all critical in-orbit burns except where it would conflict with the accomplishment of rendezvous. Critical maneuvers are defined as those maneuvers which, if dispersed by 3-sigma navigation and maneuver execution errors, could result in a trajectory that is characterized by perigee altitudes of less than 75 n.mi.

D. At least one contact with a ground station having the capability to update onboard guidance and navigation data (via command or voice) is mandatory at a time no greater than 90 minutes nor less than 30 minutes prior to those propulsive maneuvers which are independent of a rendezvous sequence.

E. It is mandatory that no maneuvers be planned which result in trajectories characterized by perigees of less than 80 n.mi.

4.1.4 Deorbit Operations

A. It is mandatory that two methods of deorbit be maintained. Sufficient ΔV must be reserved in both the SPS and a RCS (SM-RCS or SM/CM-RCS) to deorbit. The RCS deorbit must take into account the loaded, unusable SPS propellant which was reserved for SPS deorbit.

B. It is mandatory that the SPS deorbit burn be greater than 7 seconds in duration.

C. Voice communications is mandatory prior to, during, and following the deorbit burn. Telemetry and tracking coverage is highly desirable during the same period. Both telemetry

*

and voice communications are highly desirable for a 2-minute period prior to blackout.

D. It is highly desirable that the SPS deorbit attitude allow a lighted earth horizon to appear within the pilot's out-the-window field-of-view.

E. It is highly desirable that the deorbit burn occur at a time such that a lighted earth horizon is available in the pilot's out-the-window field-of-view at an altitude of 400,000 feet.

F. It is mandatory that the time of free fall from the end of the deorbit burn until entry interface be greater than or equal to 10 minutes.

G. It is highly desirable that the predicted service module impact position, including 3-sigma dispersion, avoid land masses.

4.1.5 Recovery Operational Constraints

A. The CM shall be capable of supporting the crew and recovery operations under closed hatch conditions for at least 48 hours following landings at low latitudes (less than 3~~5~~7 degrees) and 72 hours following landings at high latitudes (greater than 3~~5~~7 degrees).

B. Normal recovery operations shall be planned for water impact.

C. Planned recovery support posture for these AAP missions provides a landing opportunity in a planned landing area at least once every 12 hours. Two recovery zones will provide this capability.

*

5.1 FLIGHT CREW OPERATIONS CONSTRAINTS

5.1.1 Hazardous Operations

All three crewmen will be awake during hazardous operations, such as initial entry into MDA and OWS.

5.1.2 Watch

One crewman will be on watch within the CM at all times; however, he may be asleep or in an eat period. The crewman on watch in the CM may be scheduled to perform experiment or CM housekeeping tasks.

5.1.3 Rest and Eat Periods

A. A maximum of 8 hours and a minimum of 4 hours is scheduled between eat periods.

B. Each crewman sleeps for 8 hours and eats for 3.75 hours each day.

C. No crewman shall be awake longer than 18 continuous hours.

D. All crewmen will eat and sleep in the CM until completion of M487, Habitability/Crew Quarters setup. They will also eat and sleep in the CM from the start of deactivation through the end of mission.

5.1.4 Unscheduled Activities

Each crewman shall be allowed 1.5 hours during each 24-hour period for unscheduled activities such as rest, recreation, and personal housekeeping.

5.1.5 Systems Housekeeping

Systems Housekeeping activities must be performed three times each day within the CM, MDA, and OWS for a total of 6 man-hours. The MDA and OWS System Housekeeping is broken down into three 40-minute periods. The CM system housekeeping is broken down in 3 periods of 22, 31, and 66 minutes. LM/ATM Systems Housekeeping is assumed to be included in ATM experiment time.

*

5.1.6 Activation of OWS

Activation of OWS will start at the end of OWS pressurization in order to install seals.

5.1.7 Mission Evaluation Days

Mission evaluation days (open time reserved from experiment scheduling) occur every seventh manned day as follows:

AAP-1/AAP-2	8, 14, 21 (starting with AAP-1)
AAP-3A	7, 14, 21, 28, 35, 42, 49
AAP-3/AAP-4	7, 14, 21, 28, 35, 42, 49 (starting with AAP-3)

5.1.8 EVA

A. EVA days for ATM film retrieval in AAP-3/AAP-4 are days 17, 27, 40, and 51.

B. EVA shall be a maximum of 3 hours from egress initiate to ingress completion.

C. All crewmen will be awake during EVA operations. The crewmen will be fully prepared for each EVA, one to perform extravehicular functions and one on standby for rescue operations. Complete EVA preparation includes denitrogenization by breathing 100 percent O_2 for 2 hours and 15 minutes. The third crewman must be suited, but need not perform denitrogenization.

D. A minimum of 20 hours shall elapse between successive EVA's by the same crewman.

*

6.1 EXPERIMENTS CONSTRAINTS

This section will contain all AAP experiment constraints except those for the ATM experiments. The ATM experiment constraints are in the ATM constraints section.